Overview of Scientific Work – Omid Kermani

The scientific work of Omid Kermani spans approximately 37 years (1988–2025) and documents the development of laser-based ophthalmology, ranging from the physical foundations of excimer laser–tissue interaction to current topics such as artificial intelligence in corneal diagnostics, multifocal intraocular lenses, and simultaneous bilateral cataract surgery. Major areas of focus include refractive corneal surgery, femtosecond and excimer laser technology, laser-based glaucoma surgery, and lens surgery.

Early Phase: Laser–Tissue Interaction and Excimer Laser Fundamentals (1988–1994)

Kermani's scientific career began with experimental studies on the photoablation of biological tissue at the University of Bonn (Dardenne Clinic) in collaboration with Hans-Joachim Koort and later with physicist Holger Lubatschowski. One of the earliest studies, "Mass spectroscopic analysis of excimer laser ablated material from human corneal tissue" (J Cataract Refract Surg, 1988), analyzed the chemical composition of corneal components released during excimer laser photoablation and belongs to the pioneering phase of refractive excimer laser surgery. Parallel studies explored the use of the excimer laser in dentistry (Frentzen et al., 1989) and gynecology (Schmidt et al., 1989). These early interdisciplinary publications demonstrate that Kermani's interest extended beyond a narrowly defined clinical application toward a broader physical understanding of laser–tissue interaction.

The studies "Structure and dynamics of photoacoustic shock waves during 193 nm excimer laser photoablation of the cornea" (Fortschr Ophthalmol, 1991) and "ArF-excimer laser-induced secondary radiation in photoablation of biological tissue" (Lasers Surg Med, 1994) contributed to the understanding of shock-wave dynamics and secondary radiation. Both topics were highly relevant to safety and quality issues during the early development of LASIK and PRK and represent methodologically original contributions.

Already during this early phase, the experimental study "XeCl excimer laser photoablation of human cataract lens" (Lasers and Light in Ophthalmology, Kugler & Ghedini, late 1980s/early 1990s; the journal is no longer available) was conducted. It investigated for the first time the possibility of removing the opacified human lens using excimer laser photoablation and can therefore be regarded as a visionary precursor of today's clinically well-established laser-assisted cataract surgery, particularly femtosecond laser–based procedures.

Laser Surgery for Glaucoma (1992–1993)

During a short but conceptually independent phase of his work, Kermani established two lines of laser-based glaucoma therapy. The studies "Internal ablative sinostomy using a fiber delivered Q-switched CTE:YAG laser (2.69 µm)" (Int Ophthalmol, 1993) and "Q-switched CTE:YAG laser sclerostomies on human autopsy eyes" (Ger J Ophthalmol, 1993) document the independent development of a "cold-light" laser for photoablation. In contrast to a free excimer beam, its radiation could be delivered into the eye via an optical fiber, enabling tissue-sparing ab-interno photoablation. Conceptually, this represents foundational work for ab-interno trabeculotomy, which today has increasingly become part of clinical practice in minimally invasive glaucoma surgery using modern fiber- or excimer laser–based devices.

The study “Contact cw-Nd:YAG laser cyclophotocoagulation for treatment of refractory glaucoma” (Ger J Ophthalmol, 1992) marks the introduction of laser cyclophotocoagulation in Germany. Kermani established the procedure as an independent therapeutic option at the Department of Ophthalmology at the University of Cologne, where it continues to be used for therapy-refractory glaucoma. Internationally, cyclophotocoagulation has since become part of the standard repertoire for advanced glaucoma; Kermani’s contribution therefore lies in the early clinical implementation of a sustainably successful technique.

Refractive Excimer Laser Corneal Surgery (1998–2006)

With the establishment of LASIK in the 1990s, refractive excimer laser surgery became the central focus. Together with Lubatschowski, Kermani published “A scanning and rotating slit ArF excimer laser delivery system for refractive surgery” (J Refract Surg, 1998), documenting the development of scanning-spot and slit systems. A second line of work focused on application and outcome studies using the NIDEK platform: “Early results of NIDEK customized aspheric transition zones (CATz) in laser in situ keratomileusis” (J Refract Surg, 2003), “Hyperopic laser in situ keratomileusis with 5.5-, 6.5-, and 7.0-mm optical zones” (J Refract Surg, 2005), “Topographic- and wavefront-guided customized ablations with the NIDEK-EC5000CXII in LASIK for myopia” (J Refract Surg, 2006), and “Outcomes of hyperopic LASIK with the NIDEK NAVEX platform centered on the visual axis or line of sight” (J Refract Surg, 2009). These studies received international attention because Kermani belonged to a small group of surgeons who clinically validated the NIDEK platform at an early stage and published combinations of topography- and wavefront-guided treatments. Particularly original was the concept of hyperopic LASIK with large optical zones, which contributed significantly to improved stability in hyperopia correction.

A conceptual framework is provided by the studies on centration strategy: “Alignment in customized laser in situ keratomileusis” (J Refract Surg, 2004) and “Automated visual axis alignment for refractive excimer laser ablation” (J Refract Surg Suppl, 2006). These studies addressed the question of which reference point — pupil center, visual axis, or line of sight — should be used for centration of the ablation. The 2006 publication in particular is both original and foundational: the described method of automated alignment to the visual axis subsequently became the standard in ophthalmic excimer laser applications for refractive correction.

Transition to Femtosecond Laser Surgery (2003–2010)

One of the central themes of Kermani’s body of work is his pioneering contribution to the use of femtosecond lasers in ophthalmology, in close collaboration with the Laser Zentrum Hannover (Lubatschowski, Heisterkamp, Ripken, Oberheide). “Intrastromal refractive surgery with ultrashort laser pulses: in vivo study on the rabbit eye” (Graefes Arch Clin Exp Ophthalmol, 2003) belongs to the early in-vivo demonstrations of purely intrastromal femtosecond laser–based refractive surgery and conceptually anticipated today’s lenticule extraction techniques known as “SMILE,” as well as current non-invasive intrastromal procedures.

The study “In-vitro and in-vivo investigations on presbyopia treatment using femtosecond lasers” (Ophthalmologe, 2007) represents the world’s first published clinical study on femtosecond laser–based restoration of accommodation. Although the expected clinical effect was not achieved, the work was historically and conceptually pioneering and addressed a topic

that continues to be the subject of clinical development today (e.g., lens softening and femtosecond laser–based lens modification).

The studies “Real-time optical coherence tomography-guided femtosecond laser sub-Bowman keratomileusis on human donor eyes” (Am J Ophthalmol, 2008) and “Control of femtosecond thin-flap LASIK using OCT in human donor eyes” (J Refract Surg, 2010) are methodologically original because they combine real-time OCT guidance with femtosecond laser cutting — an approach that was only later broadly implemented in commercial platforms. These two contributions are among the internationally recognized key works within Kermani’s oeuvre.

Lens Surgery: Phakic, Multifocal, and EDoF Intraocular Lenses (2009–2024)

Parallel to refractive corneal surgery, Kermani developed a second long-standing line of work focused on intraocular lens surgery. “Dual intraocular lens implantation: Monofocal lens in the bag and additional diffractive multifocal lens in the sulcus” (J Cataract Refract Surg, 2009, with Gerten et al.) is conceptually distinctive and describes a strategy that has since become known as the “add-on IOL” technique. “Rotation stability of the cachet angle-supported phakic intraocular lens” (J Refract Surg, 2013) contributed to the clinical evaluation of a phakic anterior chamber lens that was later withdrawn from the market and is therefore of historical documentary value, although no longer directly relevant clinically.

“Häufigkeit, Ursachen und Verlauf von Explantationen multifokaler Intraokularlinsen” (“Frequency, causes, and course of multifocal intraocular lens explantations”) (Klin Monbl Augenheilkd, 2016) is clinically relevant because it systematically analyzed the complication and dissatisfaction profile of multifocal IOLs in a larger patient cohort, thereby contributing to a more realistic assessment of indications. “The Vivity IOL: the European experience” (J Curr Ophthalmol Rep, 2022, with Cummings, Savini, Carones, Ruiz-Mesa) summarizes the first European experiences with a non-diffractive EDoF lens and can be regarded as a consensus publication among leading refractive surgeons. “Femto-masking: laser-generated apertures to extend depth of focus and reduce optical aberrations in intraocular lenses” (J Cataract Refract Surg, 2022, with Dick and Lubatschowski) is conceptually original: it proposes the use of femtosecond lasers to create apertures in IOLs in order to increase depth of focus and reduce aberrations. The study lies at the intersection of laser technology and lens optics and is characteristic of Kermani’s continuous effort to transfer concepts from laser technology into lens surgery.

The study “Novel custom-made AC-IOL for aphakia – case reports” (2024) documents individualized anterior chamber lenses for complex aphakia situations and represents a clinically case-based yet technically innovative line of work.

Monovision, Conductive Keratoplasty, Cross-Linking, and TLKP

Several German-language review and experience-based articles discuss procedures that occupy niche positions within refractive practice: “Monovision und konduktive Keratoplastie” (Z prakt Augenheilkd, 2010), “LASIK-Xtra: Standard LASIK with prophylactic CXL” (Augenspiegel, 2012), “Surgical procedures for monovision” (Augenspiegel, 2016), and “Superficial, lamellar, or intrastromal? The future of refractive laser surgery” (Ophthalmologische Nachrichten, 2017). These publications summarize the German-language discussion on indications, techniques, and risks; they do not claim international originality. Nevertheless, they are

important in portraying Kermani as a practice-oriented author who critically reflects on procedures even when they remain controversial or fail to gain widespread acceptance.

“Excimer laser treatment in deep lamellar keratoplasty (TLKP) 100 µm above Descemet’s membrane” (Ophthalmologe, 2002, with Krumeich, Schöner, Lubatschowski, Gerten) belongs to a methodologically independent series of attempts to improve the precision of lamellar keratoplasty using excimer lasers; however, with the later establishment of DSAEK/DMEK, the technique did not become standard practice.

International Consortia on Corneal Biomechanics, Ectasia Detection, and Artificial Intelligence (2021–2022)

In 2021 and 2022, the character of Kermani’s publications changed: he appeared as co-author of large international consortium studies, particularly within the “International Corneal and Ocular Biomechanics Study Group” (Vinciguerra, Ambrósio, Hafezi, Roberts et al.). “Optimized artificial intelligence for enhanced ectasia detection using Scheimpflug-based corneal tomography and biomechanical data” (Am J Ophthalmol, 2022) combined multimodal tomography and biomechanical data within an AI model for early detection of subclinical keratoconus. “Detection of post-laser vision correction ectasia with a new combined biomechanical index” (J Cataract Refract Surg, 2021) belongs to the validation series of the “Corvis Biomechanical Index – Laser Vision Correction (CBI-LVC).” In both cases, Kermani’s role primarily consisted of clinical data contribution and co-authorship; methodological originality resided mainly with the lead authors.

These publications mark the transition from a primarily solo- or duo-publishing clinician to an integrated member of international multicenter research networks. The four didactic review articles published in Ophthalmology Times Europe (2022) on the “Pathophysiology and pathomorphology of corneal ectasia” (Stewart, with reviewer contributions including Kermani, Ambrósio, Reinstein, Gatinel, Hafezi) further confirm this integration.

The EUROCOVCAT studies — “Impact on refractive surgery due to increasing use of personal protection equipment” (Eur J Ophthalmol, 2021) and “COVID-19 outbreak and increased risk of amblyopia and epidemic myopia” (Eur J Ophthalmol, 2022) — are relevant as contemporary and health policy–related contributions, while “The myopia pandemic” (J Cataract Refract Surg, 2021, with Cummings) represents a concise position statement in commentary form.

Most Recent Publications (2024–2025)

“Simultaneous bilateral cataract surgery: a critical appraisal” (Z prakt Augenheilkd, 2025) reflects on a practice that continues to be handled inconsistently in Germany (ISBCS) and should be understood as a contribution to an ongoing debate involving healthcare policy and medical law. Together with the publication on individualized AC-IOLs for aphakia, this work completes the circle: both topics address the clinical margins of standard care, where individualized solutions and critical reflection are required.

Evaluation: Originality and Significance

Overall, Kermani’s work portrays an author whose principal scientific contributions lie particularly in the early and middle phases of his career: during the 1990s as one of the co-

founders of German excimer laser and photoablation research in Bonn and Cologne; during the 1990s and 2000s as a pioneer of laser-based glaucoma and lens surgery; and during the 2000s as a clinical pioneer of femtosecond laser–based corneal surgery in collaboration with the Laser Zentrum Hannover. At the same time, he belonged to the small group of surgeons who substantially published clinical data on the NIDEK platform in the international literature.

Particularly original and influential within the scientific literature are: (1) the laser-based glaucoma studies of the early 1990s, which both introduced laser cyclophotocoagulation in Germany and anticipated the currently highly relevant concept of minimally invasive glaucoma surgery through fiber-based ab-interno sinostomy; (2) the experimental work on XeCl excimer laser photoablation of the human lens as a visionary precursor of modern laser-assisted cataract surgery; (3) the studies on real-time OCT-guided femtosecond laser surgery (2008/2010); (4) the experimental contributions to intrastromal refractive surgery (2003) as a conceptual precursor of SMILE, together with the world's first clinical study on femtosecond laser–based restoration of accommodation (2007); (5) the publication "Automated visual axis alignment for refractive excimer laser ablation" (2006), whose method subsequently became standard in refractive excimer laser surgery; (6) dual IOL implantation (2009) as a precursor of today's established add-on IOL concept; and (7) the study on explantation of multifocal IOLs (2016), which helped establish the critical clinical evaluation of these lenses.

The NIDEK LASIK studies, as well as the international consortium publications on AI-assisted ectasia detection and corneal biomechanics after refractive surgery, have been widely received clinically. In these latter studies, originality is not primarily attributable to Kermani; rather, his contribution lies in clinical data provision and scientific collaboration. Excimer laser–assisted deep lamellar keratoplasty, on the other hand, ultimately did not achieve lasting relevance. The German-language review articles on monovision, conductive keratoplasty, and LASIK-Xtra are didactically valuable but not internationally groundbreaking.

Methodologically, all phases of Kermani's work are characterized by a close connection between clinical practice and engineering-based laser technology, reflected in the recurring co-authorships with Lubatschowski (Photonics, Hannover), Gerten (joint practice in Cologne), and Oberheide. Randomized controlled study designs are less prominent; many studies consist of retrospective case series, pilot studies on donor eyes, or first clinical experiences with new devices. Against this background, Kermani's body of work can overall be characterized as a practice-oriented, technology-driven, and internationally well-connected oeuvre whose principal significance lies in the early development and dissemination of laser-assisted procedures in refractive, lens, and glaucoma surgery.